DOCUMENT RESUME

ED 382 469 SE 056 238

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TITLE Middle School Mathematics Teacher Change: Social Constructivism Climbs a Step.
PUB DATE Apr 95
NOTE 18p.; Paper presented at the Annual Meeting of the National Council of Teachers of Mathematics (73rd, Boston, MA, April 1995).
PUB TYPE Reports - Research/Technical (143) -- Speeches/Conference Papers (150)

EDRS PRICE MF01/PC01 Plus Postage.
DESCRIPTORS *Beliefs; Case Studies; *Constructivism (Learning); *Educational Change; Elementary School Teachers; *Inservice Teacher Education; Intermediate Grades; Interviews; Junior High Schools; Mathematics Instruction; *Mathematics Teachers; Middle Schools; Secondary School Teachers; Teacher Role

ABSTRACT

This study examined typical backgrounds of middle school mathematics teachers, the early influences on their practice, and possible interventions that might empower them to change their instructional strategies and implement the vision of the National Council of Teachers of Mathematics as described in the "Curriculum and Evaluation Standards for School Mathematics" (1989). An intensive professional development program was offered to more than 100 middle school mathematics teachers during the summer. Five (Columbus, Ohio area) teachers were selected at random and interviewed. Transcript summaries are included. Interview data confirmed that these middle school mathematics teachers experienced success in K-12 mathematics. Three of the five teachers recognized particular classroom practices that were influences during their early school experiences. All teachers interviewed discussed problems with standardized testing and the need for alternative forms of assessment. They reported that they have changed or modified their teaching methods over the past few years as a result of ongoing professional development activities, interaction with other teachers, and reflecting on the needs of their students. This study suggests that teachers need to return to the student role as they understand and construct for themselves a new philosophy of teaching and learning mathematics and build a repertoire of new instructional strategies. (Contains 21 references.) (MKR)

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Middle School Mathematics Teacher Change: Social Constructivism Climbs a Step

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Paper presented as part of the symposium, Mathematical Autobiographies: The Impact of Teachers' Early Experiences on Current Perceptions and Decisions, NCTM Annual Meeting Research Pre-Session, Boston, Massachusetts, April, 1995

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Declining test scores, students ill-prepared for the job market, and the increasing numbers of students requiring remedial instruction in mathematics indicates a need for educational reform (National Research Council [NRC], 1989; Mathematical Sciences Education Board [MSEB] & NRC, 1991). Since the publication of the National Council of Teachers of Mathematics' *Curriculum and Evaluation Standards for School Mathematics* (NCTM, 1989), teachers, school districts, and state departments of education have begun the long process of educational reform (MSEB & NRC, 1991). Adopting learning goals and objectives in close alignment with the national recommendations are common conversations taking place in school districts across the country. Because *The Standards* are based on a theory of learning known as constructivism (NCTM, 1989, 1991; NRC, 1989), teachers must accept new beliefs and attitudes about the nature of mathematics (MSEB & NRC, 1990). As a result, classroom practice must change since constructivism also affects what it means for students to know and do mathematics (Leitzel, 1991; MSEB & NRC, 1990, 1991; NCTM, 1989, 1991). Therefore, before educational reform can begin to have lasting effects on student's mathematical learning, teachers, administrators, parents, and schools will need to change (MSEB & NRC, 1991; NCTM, 1991).

Assumptions:

Teachers who see their current practice as problematic or believe that something different would be in their students' best interest are candidates for change (Cobb, Wood, & Yackel, 1990; Shaw & Jakubowski, 1991; Tobin & Imwold, 1991). In addition, teachers must have a desire to change to endure the process as a result of their commitment (Shaw & Jakubowski, 1991).

Most middle school mathematics teachers come from "two pools" of students: (a) students in Elementary Education programs who decide to teach mathematics at the middle school level and (b) students who initially begin in Secondary Mathematics Education programs and choose to teach at the middle school level. This assumption is supported by my experience during the academic years 1982-93, while a faculty member at West Liberty State College. It was my observation that a significant number of students who began their college experience majoring in secondary mathematics education changed their program so that their mathematics specialization was at the middle school level. Several changed their specialization level following disappointing experiences (grades lower than a B or C) in first semester calculus. Many of the other students specializing in middle school mathematics education were actually majoring in elementary education and specialized in math because they were good mathematics students (among the best in the Mathematics for Elementary Teachers course). This pattern suggests that pre-service teachers may choose to specialize their teaching of mathematics at the middle school level because they enjoy and understand

mathematics more than a typical elementary education student or because they believe they lack the ability or confidence to complete the secondary mathematics education program. This assumption is further supported by data from the teachers interviewed in this study.

Purpose and Rationale

The purpose of this study was to examine how middle school mathematics teachers came to be, the early influences on their practice, and to explore possible interventions that might enable them to change their instructional strategies and empower them to implement the vision of the National Council of Teachers of Mathematics as described in the *Curriculum and Evaluation Standards for School Mathematics* (1989). The study focuses specifically on middle school teachers.

Fosnot (1989) cites Jones (1975) and Simon (1985) stating that "in spite of the efforts of teacher-education programs, teachers are much more likely to teach as they have been taught throughout their schooling than as they have been taught to teach in teacher-education programs" (p. 9). According to Tobin and Imwold (1991),

> Reform efforts are unlikely to succeed unless teachers understand the rationale for recommended reforms, believe that reforms are necessary and feasible, have a commitment to personal change, and possess a vision of an alternative curriculum that is viable in the contexts in which they are to teach" (p. 16).

Therefore, if teachers are to change their teaching practice, they must become aware of a problematic and commit to change their instructional strategies (Cobb, Wood, & Yackel, 1990; Shaw & Jakubowski, 1991). Shaw & Jakubowski (1991) have also found that teachers who receive support and have opportunity to interact with peers who are experiencing similar transitions are more likely to change. It is hoped that this study will provide insights about teacher histories, classroom practices, and the process teachers experience as they become empowered to provide learning environments where students can construct their knowledge and understanding of mathematics.

Research Questions

The following questions organized this study:

- How do middle school mathematics teachers come to be ?
- What are the early influences on their classroom practice and what effects their decision to teach at the middle school level ?
- Why do middle school mathematics teachers teach the way they do ?
- What factors influence middle school mathematics teachers to change their practice ?

Model

The diagram on the following page represents the stages of development in the life of the middle school mathematics teacher. The influences and support of their families both before and during their school years as well as the impact of their teachers and classrooms seemed to provide lasting images and examples of classroom techniques. The decisions that were made during their college years involved changing levels of mathematics instruction (from secondary to middle school), changing majors from business to education, or identification of mathematics as a specialization or area of interest while pursuing their degrees in elementary education.

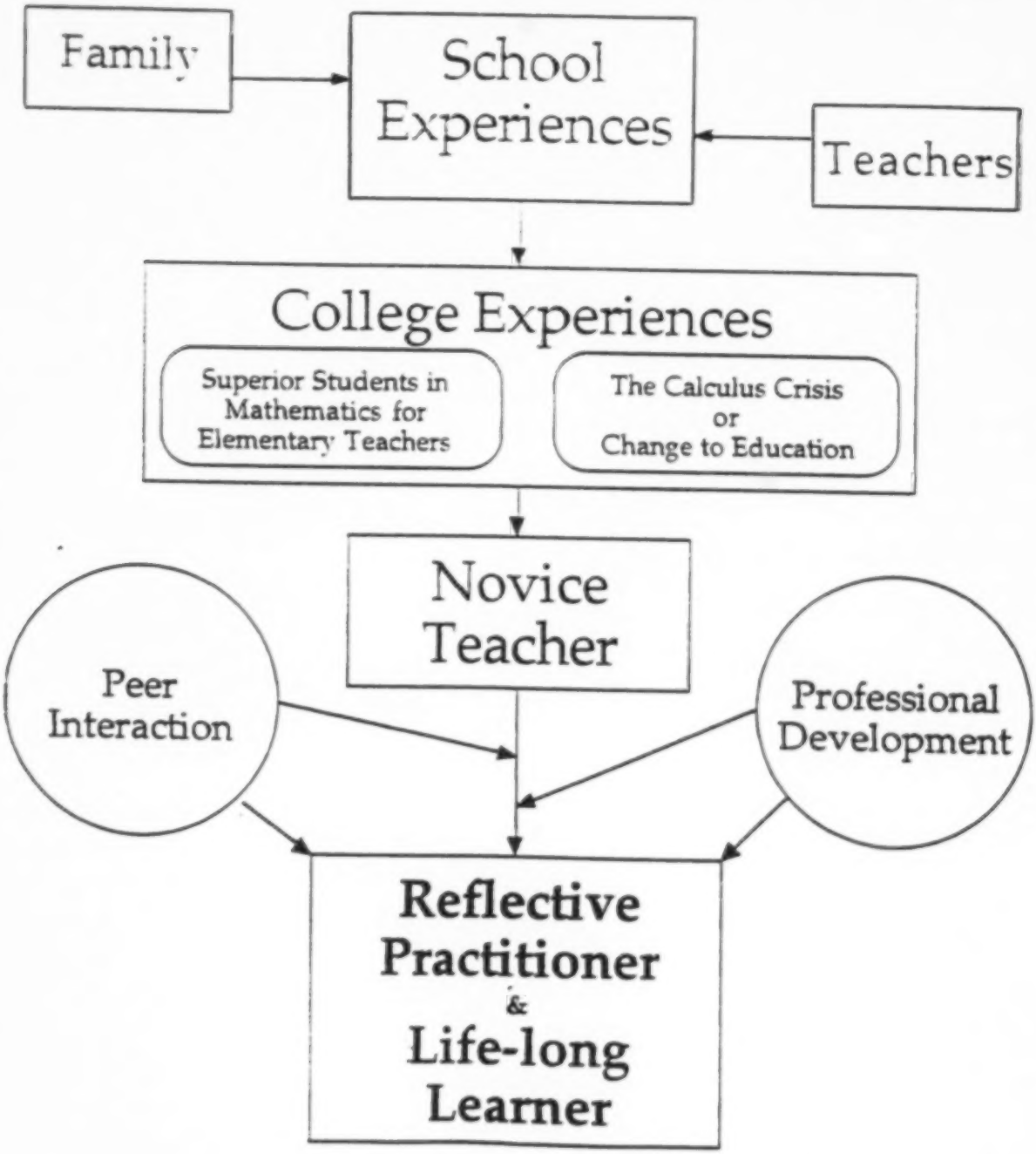
Early teaching experiences appear to be more traditional. Practice is modified as teachers interact with their peers and explore new ideas in professional development programs. These experiences cause teachers to consider alternatives to their instructional strategies. Initial success leads to further professional development and more peer interaction. The result is a teacher whose practice continues to evolve and progress through incremental changes as they reflect on themselves, their students, and as they become aware of new ideas.

The model is displayed graphically on the next page.

Theoretical Framework

Society has become aware that child abusers are likely to continue the cycle of abuse with their children, despite their contempt of this action. Simply disagreeing with a particular behavior is not sufficient to prevent it from continuing. The internal beliefs and attitudes formed in the early years of education form strong convictions in the minds and hearts of students and future teachers (Cobb, Wood, & Yackel, 1990; NCTM, 1989). The fact that many teachers continue to teach in traditional classroom settings, making only the slightest changes, confirms their comfort and confidence in their own school experiences. For these teachers, changing their classroom practice is even more difficult because their early success of learning in traditional classrooms may encourage them to use the same methods with their students and expect the same results. However, the change in what we believe about mathematics and how students learn mathematics have altered what it means to be successful in a mathematics classroom (Leitzel, 1991; MSEB & NRC, 1990, 1991; NCTM, 1989, 1991). Before teachers will consider alternative forms of instruction, I believe, as others (Cobb, Wood, & Yackel, 1990; Shaw & Jakubowski, 1991), that they must be first convinced that there is a need to reconsider their traditional teaching of mathematics - after all, why fix what isn't broken. Reports such as the Results of the National Assessment for Educational Progress (NAEP) by the

History, Development, and Changing Practices of **Middle School Mathematics Teachers**



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U. S. Department of Education (Mullins, 1993) and others inform us of the declining test scores and inferior performance of American students (MSEB & NRC, 1991). The publication and distribution of several documents during the 1980s, including: the National Council of Teachers of Mathematics' *Curriculum and Evaluation Standards for School Mathematics* (NCTM, 1989) and *Everybody Counts* (NRC, 1989) reported the weaknesses in the traditional education system and call for educational reform, particularly in the area of mathematics.

While several educational theories may be used to justify a shift in classroom practice and changes in teacher education programs, the recommendations from NCTM, through their *Standards* (1989, 1991) seem to be strongly supported by educational theories of constructivism. No doubt the ideas presented by constructivists shake the very foundations of some teaching philosophies, since it causes us to question our beliefs about the very nature of mathematics and what it means to know and do mathematics (Leitzel, 1991; MSEB & NRC, 1990, 1991; NCTM, 1989, 1991). During the past two years I have observed a variety of elementary, middle school, and secondary school classrooms. It has been my observation that primary classrooms demonstrate that teachers at this level seem to be more accepting of change and adapting to the recommendations of the NCTM *Standards* (NCTM, 1989, 1991) and have made more progress toward implementation of the *Standards* than teachers at higher levels. Most secondary classrooms where I have observed are still very traditional as teacher-centered lessons and teacher talk dominates instructional practice. Additionally, colleges and universities are now struggling with the problem of offering remedial courses for students who have not been successful in traditional classrooms, yet they teach remedial classes using many of the same teacher-centered strategies with similar results (Leitzel, 1989; Treisman, 1985). This seems to indicate that there are deep-rooted values and beliefs about mathematics and how students learn mathematics that are held by many teachers at the middle, secondary, and college levels. Because student learning is so strongly influenced by teacher knowledge and beliefs (MSEB & NRC, 1991), it is at this point, that of the teacher's beliefs, that educational reform and teacher change must begin, if a significant impact is to occur beyond the primary grades.

Social Constructivism & Classroom Practice:

> In reality, no one can teach mathematics. Effective teachers are those who can stimulate students to learn mathematics. Educational research offers compelling evidence that students learn mathematics well only when they construct their own mathematical understanding. . . . This happens most readily when students work in groups, engage in discussion. . . (NCR, 1989, p. 59).

The recommendation that teachers use instructional methods that are based on constructivism is grounded in

the theories of Piaget, Dewey, Bruner, and others who believe that "mathematical concepts and skills are best learned as part of a dynamic process with active engagement on the part of students" (Johnson & Johnson, 1990, p. 107). In particular, "active learning requires intellectual challenge and curiosity, which are best aroused in discussions with other students" (p. 107). Social constructivists base their theories on these principles, believing that students learn and have higher levels of understanding when they are stimulated by challenging activities in which they reason, conjecture, explain, resolve conflicts, and reflect on their learning process (Cobb, Wood, & Yackel, 1990; Davis, Maher, & Noddings, 1990; Fosnot, 1989; NCTM, 1991). This type of opportunity is made available as students work in groups where they form mathematical communities and subcultures within the classroom (Burton, 1993; Davis, Maher, & Noddings, 1990; Johnson & Johnson, 1990; NCTM, 1991). We will see that these benefits will also be experienced by teachers as they portray the role of students in the professional development program.

The types of activities that are often incorporated in a constructivist's classroom will result in changing roles for the teachers as well as the students.

> Because student communities necessarily lack the experiences and authority of expert communities, teachers bear a great responsibility for guiding student activity, modeling mathematical behavior, and providing the examples and counterexamples that will turn student talk into useful communication about mathematics. Such responsibility requires teacher behaviors and beliefs quite different from traditional ones (Davis, Maher, & Noddings, 1990, p. 3).

Just as students lack mathematical expertise and need teachers to provide examples and counterexamples to stimulate their activities, teacher participants lack the particular mathematical knowledge for the mathematical content recommended for the 21st century (NCTM, 1989). While these teachers were successful mathematics students in traditional classrooms, many have not had the opportunity to gain adequate knowledge and experience in problem solving, probability and statistics, integrating curriculum areas, and other contemporary recommendations for classroom practice. According to the NCTM *Professional Teaching Standards* (1991),

> The teacher's role is to initiate and orchestrate . . . discourse and to use it skillfully to foster student learning. In order to facilitate learning by all students, teachers must also be perceptive and skillful in analyzing the culture of the classroom, looking out for patterns of inequality, dominance, and low expectations that are primary causes of nonparticipation by many students. Engaging every student in the discourse of the class requires considerable skill as well as an appreciation of, and respect for, students' diversity (p. 34).

The role is further described by Noddings (1990) as she suggests that

> To teach well, we need to know what our students are thinking, how they produce the chain of little marks we see on their papers, and what they can do (or want to do) with the materials we present to them. But the cognitive premises of constructivism can dictate only guidelines for good teaching (p. 15).

In these quotations, we see a classroom teacher far different from the traditional graduates of our teacher education programs who have completed our methods courses. These teachers will need to plan lessons which are not prescribed and predictable. The days of rehearsed lectures where almost every topic and example can be anticipated in advance are replaced by the flexibility of following the inquiry of the students. One must be careful, however, not to assume that there will no longer be learning outcomes or consensus on course syllabi, but we must discard the assumption that all students will learn the same material at the same time in the same order at the same age (Burton, 1993).

Once the class begins, the management skills required for student interaction are far more complex as teachers consider how to structure groups to work together affectively, rather than just being sure that student behavior is adequately under control and appropriate equipment is selected for student use. Finally, teachers must have considerable knowledge themselves about the knowledge base of mathematics accepted by the larger expert community. Such "super-teachers" can scarcely be expected to emerge from four-year teacher education programs which include this as one component and certainly the teachers who are currently faculty members at the middle grades have not had this experience either. Schon (1987) describes this new teacher role as a coaching metaphor, viewing the teacher in much the way we would view other professionals where specific recommendations are used to guide practice, but that fixed solutions are not available for each problematic situation. Such vocations would include lawyers, doctors, and managers who reflect on situations and use professional judgment to both initiate action or react to situations. This role is referred to as 'the teacher as reflective practitioner'. Therefore, the teacher role can no longer be taught in its entirety, but will be experienced and developed in terms of guidelines and acceptable standards of practice (Schon, 1987).

To induce this change in role, teachers need to experience first-hand the types of activities and learning environments they are expected to create in their own classrooms (Cobb, Wood, & Yackel, 1990; Fosnot, 1989; Steffe, 1990). According to Murray, "the current reform proposals will fail as they have in the past, because they attempt to reform education simply by telling teachers (and everyone else) what to do, rather than by empowering them to do what must be done" (Murray, p. 29). Fosnot adds, "since they are actively questioning and investigating techniques of instruction, they become empowered, 'thinking' teachers, rather than teachers who rigidly follow a cookbook approach to instruction" (p. 16). It seems apparent that a setting for teachers to work cooperatively with their peers during their professional development activities would provide all the benefits of social constructivism that will be experienced by their students as they gain

valuable insights by listening to their colleagues and exchanging ideas for classroom practice (Fosnot, 1989). Therefore, it is important to conduct professional development activities in such a way that teachers are asked to participate in a dual role: that of a student who is experiencing new content or old content in new and more meaningful ways, and that of a teacher reflecting on how these activities might be implemented in their own classrooms.

Benefits of social constructivism for the TEACHERS will include:

- Participants becoming aware of the changing beliefs of what it means to learn and do mathematics because of their experience, rather than being told they are teaching wrong.
- Participants will learn or relearn mathematical content in meaningful ways, making conceptual ideas rather than algorithmic procedures the foundation of their knowledge base - providing them more confidence and ability in assessing student understanding and guiding student practice.
- Participants become aware of alternative teaching methods and experience their effectiveness compared to traditional instructional strategies.
- Participants beliefs will begin to change as they experience mathematics and its applications in ways that are different from what they learned in school. These new and exciting activities which challenge the teachers will be both motivating intellectually and will also convince them of the benefits to their students, thus motivating them to commit themselves to the process of teacher change.
- Participants will have an opportunity to experience the activities with their peers, providing an opportunity to reflect on their learning through discussions, experience mutual support and encouragement for teacher change, and practice cooperative learning as an alternative instructional setting.

Method:

An intensive professional development program was offered to more than 100 middle school mathematics teachers during the summer with graduate course credit. This one-week course was used to provide teachers with actual experiences that they could use with their students. Teachers were provided opportunities to participate as students in order to gain the advantages suggested by the list of benefits enumerated above. Therefore, participants worked in groups while solving a variety of problems and real-world applications. Time was also provided for reflection, discussion, and interaction with peers. Occasionally local or visiting teachers who had tried the methods shared their classroom experiences.

Research Method:

Five Columbus area teachers were selected at random from the participants of the intensive middle school mathematics professional development program of more than 100 teachers (more than 95% were from the Columbus area). These five teachers, all of whom happen to be white females, have taught mathematics

less than 10 years. They were interviewed and transcripts analyzed for beliefs and influences in their previous and more recent teaching practice. Data was compared between transcripts to get a general profile of a typical middle school mathematics teacher and individual responses considered to reveal the types of interventions which enable teachers to change or modify their classroom practice.

Interviewees

Summaries from the individual transcripts have been included to provide an opportunity for the readers to become acquainted with the teacher-participants included in the sample.

Carrie

Carrie has always enjoyed math, from the early days when her math teacher father would quiz her and an older brother during family outings. One of only two girls in her high school class who went the "scientific route," Carrie was a math major in college until she failed calculus and changed to a physical education program. She eventually received her degree in elementary education. In many ways, Carrie is not a traditional teacher: team teaching (although ability grouping), viewing testing as a part of the learning process, and using alternative forms of assessment. In other ways she is quite traditional: seeing math as doing the same thing over and over again - claiming that things look different but are not, and having a very standard classroom routine (go over work, introduce new material, and begin seatwork for student questions). Manipulatives are available but not often used by her students. She says her practice is mostly influenced by other teachers, professional development activities and being a mother - the most natural form of teaching.

JoAnne

JoAnne did not have particular recollections of her early math days, but the fact that she mentioned that she had no "horror stories" suggests that she has heard a few. Having started college as a math major, JoAnne changed to elementary education following a bad experience in calculus.

JoAnne is a very traditional teacher - but I think she may be "on the edge of change." Although she says she does not have many "hands-on activities" she said that she does use learning centers in her classroom. She said that discipline problems cause her to use more individual seat work than group learning in her classroom, even though she recognizes the advantages of students explaining things to each other when they do work at the centers. She does talk about making manipulatives available and the importance of practical applications for students. She sees her role as one of preparing students to go on to middle school.

JoAnne said that she used math journals, but that she found them a good indication of how she is

doing rather than using them as part of the student's assessment.

Sandi

Sandi has always liked math, but began college as a business major before changing to elementary education. She said that she did not find the required math classes very challenging. Her only bad experience was with a 7th grade teacher who apparently scared her and she had test-phobia for part of the year. She enjoyed chanting the multiples during classes and still uses it in her classroom.

Sandi sounds like a teacher in transition - going over homework, answering questions, and introducing the new lesson, however, she also talks about students working in groups and completing labs the second day of a new unit. Along with wanting to use more group activities, Sandi talks about assessment including homework effort, observation, and consistency in additional to traditional testing.

Sandi believes that every teacher she has ever had has influenced her. She sees herself as being traditional and realizes that she has a hard time relinquishing control. She still believes in a teacher-directed classroom, but likes the ideas of "guided discovery." She discussed the importance of students making connections and being more active (use manipulatives). She wants to use more problem solving and less drill and practice during the coming year. Calculators are sometimes available. She said there is pressure to teach toward the test and that schools have changed considerably because of social problems and emotional baggage that students bring to school.

Shelley

Shelley took all the advanced math courses as a student and entered elementary education after changing from business. She took probability and statistics in her business program and did not feel challenged by the elementary education courses.

Shelley voluntarily participates in a state inclusion project which provides her the opportunity to participate in team-teaching and cooperative learning. She describes her desk as a "dumping ground" in the back of the room and says that her role has changed from dictator to facilitator. She said her students are active participants and she uses a variety of assessment techniques. She and her students use reflection to realize how far they have come.

Shelley believes that her practice is influenced by peers, students, and her personality. She tries to participate in professional development activities each year. Shelley helps to explore the use of writing in her classroom and continue to explore alternative forms of assessment during the coming year.

Kate

Recently appointed as a Chapter 1 teacher, Kate always thought she would be teaching Language Arts. Although math was her favorite subject, she took only the required 10 hours for elementary education majors in college.

Kate describes herself as a non-traditional teacher, however, I think this may be masked by the special students that she teaches rather than her philosophy of teaching - I'd like to see Kate with "typical students in a typical classroom" before describing her as traditional or non-traditional. Kate says that math is a major emphasis and is taught for 2 periods each day in her classroom. Individualized mastery learning with plenty of one-on-one interactions seems to describe a more traditional classroom to me, even though she does reveal that students have a lot of manipulatives and practical projects, problem solving, and hands-on activities in her classroom. She wants students to avoid seeing math as an isolated topic and view it instead as part of their everyday life. She sees her role as providing opportunities for these active learners.

Kate said that nobody in the class is allowed to get an F. She talks about the proficiency test as being appropriate for some, but not for her school or her students - so she writes her own tests. She believes alternative assessment is for everybody, but talks about her daughter needing to do well on the CBE and proficiency tests for college entrance and scholarships. Kate looks for strengths and weaknesses in her students and evaluates them on such things as effort, risk-taking, cooperation, completing assignments, and progress. She wants her students to experience success.

She said that her practice has been influenced by methods classes and professional development programs that she continues to be involved in. As a life-long learner, she wants to maintain her level of enthusiasm. She also recognizes the importance of interacting with other teachers.

Results and Discussion

"How do middle school mathematics teachers come to be ? In particular, what are their early influences and what effects their selection to teach at the middle school level ?" Interview data confirms that middle school mathematics teachers have experienced success in K-12 mathematics. Teacher responses revealed that these participants enjoy mathematics and have sufficient knowledge that they did not find the required two quarter courses for elementary teachers particularly challenging. Thus, they were among the stronger mathematics students in the classes. At least two of the teachers had disastrous experiences in calculus and changed their major from mathematics to elementary education. Carrie described her experience and told me that at the time she changed programs that she was "still liking math. Went back, by the way,

retook the calculus course because of the F on my grades.... and the second time around it clicked in - all of a sudden, for whatever reason, I understood what was going on and I ended up - I got a B.... " She goes on to say that she thinks similar things happen to her students in trying to make the jump to algebra or geometry. In spite of their early success, teachers reliance on the text indicates that many may lack the confidence and knowledge in selecting appropriate mathematics content and instructional strategies. Therefore, even these teachers with previous success in mathematics have a need to be exposed to more content.

Three of the five teachers interviewed definitely recognized particular classroom practices that were influenced by their teachers during their early school experiences. For example, Sandi described experiences where "we had contests. We had to count by 1s, 2s, 3s, 4s, all the way through to - I guess tens - and he timed us. So he got us to learn our multiplication tables if we hadn't memorized them already. I think that taught me.... I use that more on a day-to-day basis than any other single thing I've ever learned in math."

"Why do middle school mathematics teachers teach the way they do ?" Factors which received mixed support for influencing teacher practices were previous teachers and experiences, methods courses, and their personal philosophies of teaching. Despite studies by Emans and MacIntyre cited by Koerner (1992) which indicate that teachers are strongly influenced by their cooperating teachers, none of the five teachers interviewed indicated that their cooperating teachers had any effect on their classroom practice.

Comments about previous school experiences point to the idea that teachers have formed examples in their minds concerning their ideas of what classrooms and mathematics lessons look like as they reflect on their own learning. These data denote the traditional styles of classroom activity that the participants used in their classrooms - going over homework, introducing the new material, and providing time for practice. Having been exposed to little else, these teachers appear to be doing what they know to do. These teachers, however, also describe how their practice has been modified, evolving in recent years toward classroom activities which incorporate the use of cooperative learning, manipulatives, problem solving, real-world applications, and student projects.

All teachers interviewed discussed problems with standardized testing and the need for alternative forms of assessment. Most also indicated that the format and content of the tests needed to be revised because it was "not measuring math" abilities. Shelley, in discussing the standardized tests said that she "doesn't always feel that those are indicative of what the kids know." Teachers were also quick to say that they were aware of the NCTM *Standards*, but did not want to be asked to state any of them. This suggests that these teachers are becoming aware of the changes in beliefs about mathematics and how students learn

mathematics and are exposed to current professional literature. One teacher (Kate), however, while describing her Chapter 1 classroom and her practice as non-traditional, also said that she wanted her daughter to do well on the standardized tests and that they were needed for college-preparatory students. She said that since only a small portion of students from her school go on to college the standardized tests seem stupid. She also said that her students needed life-skills and that she does not permit students in her class to receive an F. Her remark that "I'm really struggling with a lot of things these days..." seemed to be implied by other teachers, expressing their discomfort and battle with their beliefs about mathematics, teaching, and learning. Many of the teachers are experimenting with alternative forms of assessment and another teacher said she likes to use journal writing - but that she uses it more for assessing herself rather than her students. It would seem, therefore, that some teachers teach the way they do because of the lack of support they receive "in the system." By this I mean the system in general. Standardized tests continue to assess algorithms and correct answers without rewarding the creative and critical thinking that we suggest is important for students in the 21st century (Mullins, 1993; NCTM, 1989). Schools, teachers, and students continue to be compared and ranked by quantitative measures that almost force teachers to make conservative changes at best. Support from administrators and school environments would encourage teachers to take risks and use modern teaching practices which provide opportunities for students to construct their own knowledge. In fact, four of the five teachers interviewed said that informal interactions with their peers and the support from their school environment was a major contributor to their change in classroom practice. Four of the five teachers interviewed also said that reflection on themselves and their students was a major factor. Their belief seems to be that "success breeds risk" and that as they see things working they are more willing to try more ideas in their classroom. This success may take place in the professional development activities, other teachers' classrooms, or their own classrooms.

"What other factors might influence middle school mathematics teachers to change their practice ?" All of the teachers reported that they have changed or modified their teaching methods over the past few years as a result of ongoing professional development activities, interaction with other teachers, and reflecting on their students and the needs of their students. These three factors, in particular, seemed to consistently influence the teachers as they began to modify their practice. All teachers interviewed were aware of the NCTM *Standards* and all of them indicated that they were in transition (some more than others). Some see participants who are involved in professional development activities as "the converted." Therefore, these teachers believe that there is high correlation between the teachers who are implementing

recommendations for educational reform and those who participate in professional development activities. This suggests that awareness of a problem is the first step toward change and that teachers are interested in opportunities where they can learn about and experience alternative teaching methods.

Particular hands-on experiences with the classroom activities were both enjoyable and impressive as teachers indicated that they remember more from what they do during the inservice programs than what they hear. They also said that when they receive activities but do not actually participate or see them demonstrated that they are sometimes forgotten or time is never found to scan them for possible classroom use. Finally, teachers indicated that testimonials from those who had tried some of the methods and activities in their classroom were particularly inspiring, especially when the endorsement came from local teachers who share the same school settings and characteristics as the participants.

Further research is needed particularly in the area of identifying teachers who are unaware of current shifts in both theory and practice. These teachers, who are not likely to be at the professional development activities or reading the literature, may not be aware that alternative strategies are available and recommended for classroom use. Studies which inquire about how teachers, who are less likely to attend inservice workshops, might (1) become more aware of educational reform, (2) become aware of the problematic nature of traditional teaching practices, and (3) be encouraged to consider alternative instructional strategies in their classrooms would be especially useful.

Summary

Many teachers demonstrate traditional classroom practice similar to that used during their own education experiences. Until this practice is identified by the teachers as being problematic and alternative strategies presented that are more capable of providing more successful learning environments for students, teachers will be reluctant to change. Once they are aware of this option, commitment on the part of the teacher will be necessary to begin the process and endurance of long-term changes.

Social constructivism has been recognized as a powerful setting for student learning. This study suggests that teachers need to return to the "student role" as they understand and construct for themselves a new philosophy of teaching and learning mathematics and build a repertoire of new instructional strategies. Because teachers have expressed the need for both hands-on experience with classroom activities and sufficient time for peer interaction, it is both useful and necessary for professional development programs to use innovations which incorporate the benefits of social constructivism. Additional benefits from this approach result because of the unique responsibilities of middle school mathematics teachers. Some people

believe that of the two groups of pre-service teachers who become middle school mathematics teachers, the elementary education majors need to be exposed to more mathematics content and secondary education majors need to be exposed to more instructional techniques often taught in the elementary mathematics methods classes. By providing this shared experience, both groups of participants strengthen their deficiencies through the presentations and, more importantly, from each other. Activities based on social constructivism offer the perfect setting to accomplish this task.

Descriptions of activities and teacher changes reveal that these teachers are successfully beginning to make the transition from traditional teacher to one whose students are provided the environment and opportunity to construct their own knowledge as well as experience success and confidence in the mathematics classroom.

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